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01 October 2008

Our ref: TS 7640 EPC P

European Patent Application No. 04804628.8
Shell Internationale Research Maatschappij B.V.

Dear Sir or Madam

Reference is made to the Communication pursuant to Article 94(3) EPC dated 15 February 2008 in respect of the above application.

Hereby the Applicant requests further processing under Art. 121 EPC. Please find attached a voucher for payment of the further processing fee.

Amendments

We herewith submit a set of further amended claims to replace those presently on file. Claim 1 has been amended, basis claim 1 on file and Claim 10. Claim 10 has been cancelled without prejudice. Claims 11 to 13 have been renumbered accordingly.

Furthermore, we submit a hand-amended page 9 to replace page 9 presently on file. For clarification, we refer to the amended set of claims and the hand-amended page enclosed.

1. Novelty

None of the documents D1-D3 discloses a process with all the features of further amended claim 1. In particular D1, contrary to the statements in the IPRP, does not disclose a direct exhaust gas recycle.

Accordingly, we consider claim 1 as novel. Claims 2 to 13 are novel by virtue of their dependency on claim 1.

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2. Inventive step in view of D2 (US-A-2003/0115857)

As set out previously, we consider D2, or more specifically the embodiment disclosed in Figure 4 and [0024]-[0026] as closest state of the art, since it relates to the same field (process for operating a combustion engine with exhaust gases), and since it is equally concerned with the provision of a solution to NOx abatement process.

The mentioned embodiment of D2 discloses a process for the catalytic exhaust gas after-treatment of engine combustion emissions by an NOx storage catalyst which can be regenerated by feeding hydrogen to the exhaust gas upstream of the NOx storage catalyst. This is achieved by operating an internal-combustion engine and in parallel a reformer for producing a hydrogen-rich synthesis gas on a hydrocarbon fuel, such as gasoline or Diesel. The synthesis gas prepared in the reformer is then employed to drive a solid oxide fuel cell and for the regeneration of a NOx storage catalyst.

The present invention differs from that disclosed in D2 in that a fuel composition comprising a Fischer-Tropsch derived hydrocarbon stream for both the compression ignition engine, as well as the catalytic partial oxidation reformer. Furthermore, the present process differs in that an enriched exhaust gas recycling process (enriched EGR) is applied.

The technical effect of the use of the exhaust gas recycle is that synthesis gas can be introduced into the engine without reaching flammability limits (see page 10, lines 1-23), thereby inherently operating safely while allowing optimal exhaust gas treatment.

Accordingly, the objective problem in view of D2 can be formulated as to provide for a process for the operation of a combustion ignition engine with improved NOx abatement performance due to an enriched EGR.

D2 does not teach or suggest use of a specific fuel, nor of an enriched exhaust gas recycle. Accordingly, we consider the process according to claim 1 non-obvious in view of D2.

We further note that none of D1 or D3 disclose an enriched exhaust gas recycle. Accordingly, there is no reason why a skilled reader could have arrived at the process according to further amended claim 1. Accordingly, claim 1 is inventive over D2, and any combination thereof with D1 or D3.

To summarise, we are of the considered opinion that the process according to claim 1 is inventive over D2, and any combination thereof with D1 and/or D3. Claims 2 to 12 are inventive by virtue of their dependency on claim 1.

Yours faithfully
Shell International B.V.

A. Krebs (GA17132)



Encls. Set of amended claims, amended page 9, Voucher for Further Processing

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02. 10. 2008

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In another embodiment of the invention, the NO_x abatement systems comprises two NO_x traps as described hereinbefore. The two traps are operated in a so-called swing mode. One trap is supplied with exhaust gas and absorbs NO_x (absorption mode) and the other trap is supplied with synthesis gas and desorps NO_x that is reduced to nitrogen (regeneration mode) and vice versa. Each trap is thus alternately supplied with exhaust gas and synthesis gas. An advantage of this swing mode operation as compared to the above-described operation of a single trap is that the regeneration is performed in the absence of oxygen, resulting in a more efficient regeneration.

A specific advantage of the use of Fischer-Tropsch derived fuel in both the engine and the reformer is that the fuel contains no sulphur and thus, the exhaust gas and the synthesis gas will contain less sulphur oxides. Sulphur oxides can strongly adsorb on a NO_x trap and thus have a negative effect on the performance of such trap.

In still another embodiment, the NO_x abatement system, comprises a NO_x reducing catalyst without a NO_x sorbent. Such NO_x abatement systems are known in the art. Typically, such systems comprises a platinum supported on a zeolite. Exhaust gas and synthesis gas are simultaneously supplied to the catalyst. The catalyst promotes the reduction of NO_x to nitrogen; the synthesis gas acts as reducing agent.

In a second aspect of the invention, at least part of the synthesis gas is supplied to the combustion chamber of the engine. In one embodiment ^{not according to the invention} (fumigation), synthesis gas is supplied to the combustion chamber by mixing it with the intake air prior to introducing the air to the

02. 10. 2008

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TS 7640 EPC PC L A I M S

1. A process for operating a compression ignition internal combustion engine in combination with a catalytic partial oxidation reformer and a NO_x abatement system as exhaust gas aftertreater, wherein:

5 (a) a mixture of a first fuel and air, wherein the first fuel comprises Fischer-Tropsch derived fuel, is introduced in the combustion chamber of the engine;

(b) exhaust gas is discharged from the engine and at least in part recirculated to the combustion chamber of the engine;

10 (c) a second fuel and oxygen and/or steam are supplied to the catalytic partial oxidation reformer to produce synthesis gas, wherein the second fuel comprises Fischer-Tropsch derived fuel;

15 (d) at least part of the synthesis gas is supplied to:

(i) the exhaust gas aftertreater;

(ii) the combustion chamber of the engine; or to both; and wherein the non-recirculated part of the exhaust gas and at least part of the synthesis gas are supplied to the NO_x abatement system.

20 2. A process according to claim 1, wherein the first fuel and the second fuel are the same fuel.

25 3. A process according to claim 1 or 2, wherein the first fuel and the second fuel comprise at least 10% (v/v) Fischer-Tropsch derived fuel, preferably at least 50% (v/v), more preferably at least 80% (v/v), even more preferably consist of Fischer-Tropsch derived fuel.

4. A process according to any one of the preceding claims, wherein the Fischer-Tropsch derived fuel is a gasoil.

5. A process according to any one of claims 1-4, wherein
5 the NO_x abatement system comprises a NO_x trap comprising a NO_x reducing catalyst and a NO_x sorbent.

6. A process according to claim 5, wherein the non-recirculated part of the exhaust gas is continuously supplied to the NO_x trap and the synthesis gas is
10 intermittently supplied to the NO_x trap.

7. A process according to claim 5, wherein the NO_x abatement system comprises two NO_x traps and wherein each trap is alternately supplied with the non-recirculated part of the exhaust gas and the synthesis gas such that
15 one trap is supplied with the exhaust gas and the other trap with the synthesis gas.

8. A process according to any one of claims 1-4, wherein the NO_x abatement system comprises a NO_x reducing catalyst without a NO_x sorbent and the non-recirculated
20 part of the exhaust gas and the synthesis gas are simultaneously and continuously supplied to the NO_x reducing catalyst.

9. A process according to any one of the preceding claims, wherein at least part of the synthesis gas is
25 supplied to the combustion chamber of the engine.

10. A process according to claim 9, wherein the amount of synthesis gas supplied to the combustion chamber of the engine is such that the volumetric ratio of 'synthesis gas'-to-'first fuel' supplied to the combustion chamber
30 is at most 25%, preferably at most 20%.

11. A process according to claim 9 and 10, wherein the amount of synthesis gas supplied to the combustion

chamber and the amount of exhaust gas recirculated to the combustion chamber is such that the volumetric ratio of 'combined synthesis gas plus exhaust gas' to 'first fuel' supplied to the combustion chamber is at most 25%.

- 5 12. A process according to any one of the preceding claims, wherein part of the synthesis gas is supplied to a fuel cell to generate electricity, preferably a solid oxide fuel cell.